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SCIENCE

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THE SIZE OF THE UNIVERSE[1]

THE century in which we live promises to make an incalculable advance in man's power of exact measurement. "Nearly all the grandest discoveries of science," says Lord Kelvin, "have been but the rewards of accurate measurement and patient, long-continued labor in the minute sifting of numerical results." The opening decades of the century have witnessed the emergence of a number of fundamental natural phenomena, the explanation of which defies all the mighty power of Newtonian mechanics. The Newtonian laws have hitherto been found adequate to explain large-scale phenomena; but there seems convincing reason for grave doubt as to their applicability to small-scale phenomena. "The old laws," as Jeans observes, "are not, so to speak, fine-grained enough to supply the whole truth with regard to small-scale phenomena." Nor are they exact enough to explain very minute changes in large-scale phenomena. Conspicuous among contemporary theories which throw grave doubt upon the universal applicability of the Newtonian mechanics are the electron theory of Lorentz, the quantum theory of Planck and the relativity theory of Einstein. The Lorentz transformation, basic in the electron theory, belies Newton's ideas of absolute space and time. Crucial in the quantum theory is the phenomenon that "the total radiant energy per unit volume of ether in temperature-equilibrium with matter is finite"; and to explain the facts of radiation according to Planck's law the Newtonian mechanics are inadequate. The remarkable explanation of the observed discrepancy in the advance of the perihelion of Mercury, and the phenomenal accord of observation with theory in the matter of the light-ray deflection announced by W. W. Campbell a few weeks ago, thitherto unexplained by the Newtonian mechanics, constitute supreme triumphs for Einstein's relativity theory.

To-day are going forward profound investigations, at each end of the scale of magnitudes—towards the infinitesimal and towards the infinite. Methods of almost incredible refinement are being devised for determining the scale of the atom and the scale of the universe. The investigations of Rutherford have virtually set it beyond doubt that the atom consists of a central nucleus of almost infinitesimal dimensions, and of electrons revolving in planetary manner

[1] Presidential address before the North Carolina Academy of Science, Greensboro, N. C., May 5, 1923.

around the nucleus. The hydrogen atom consists of a negative electron revolving in an orbit round a positive nucleus of equal charge, while the helium atom consists of two electrons revolving in orbits round a nucleus with a positive charge equal in amount to twice that of an electron. The scale of the universe to the atom is believed to be 10^{22} to 1. The radius of the solar system is 10^{14} centimeters. This, on dividing by 10^{22}, becomes 10^{-8} centimeters, the radius of an atom. As Aston recently pointed out, "the atom, like the solar system, is *empty;* and what we measure as its spherical boundary really only represents the limiting orbits of its outermost electrons." An atom of hydrogen, on being enlarged by the factor 10^{22}, would become of the same size as the solar system; and its two planetary electrons would closely resemble Uranus and Neptune as regards size, distance from the sun and period of revolution. If in the atom of helium, for effective comparison of size and distance, the nucleus were represented by a rather large pea, its planetary electrons would be represented by two somewhat smaller peas revolving around it at the distance of a quarter of a mile.

These investigations of the atomic microcosm have concentrated attention upon the fundamental structure of the universe. It would seem that aggregations of matter, ranging from the infinitesimal to the infinite, possess the features of the solar system. Each particle of the atom may be a little world after analogy with this world now rotating beneath our feet at the rate of 1,000 miles per second. Our solar system is one among countless many others of the Milky Way; and perhaps the Milky Way is but one of countless giant nebulae whirling in spiral form through a space that may be infinite. While the mathematicians and the physicists, Lorentz, Planck, Poincaré, Thomson, Rutherford, Millikan, Soddy, have been turning their brains, their microscopes and spectroscopes to a study of the atom, the astronomers, Shapley, Kapteyn, Russell, Hertzsprung, Eddington, DeSitter, Curtis, have been utilizing their telescopes, interferometers and coelostats in the study of the new heavens revealed by the epochal advances in photography and spectroscopy. Until the time of Galileo, the "crystalline lens of the human eye, limited by the iris to a maximum opening about one quarter of an inch in diameter," was the only collector of starlight. Galileo's telescope, of 1610, with a lens-area about eighty-one times that of the pupil of the eye, vastly extended for the astronomer the boundaries of the visible universe, bringing to view stars down to the magnitude, 10.5, of which nearly half a million are known to exist. Through the development of the photographic telescope and the use of the spectroscope, within recent years, astronomers have caught hundreds of millions of star-images upon the photographic plate and for the first time through spectral images and luminosity curves began to make some credible computations regarding the scale of the universe. In his presidential address before the British Association for the Advancement of Science, Eddington recently remarked: "Probably the greatest need of stellar astronomy at the present day, in order to make sure that our theoretical deductions are starting on the right lines, is some means of measuring the apparent angular diameter of stars." Recent observations at the Mt. Wilson Observatory, with the use of the Michelson interferometer, have greatly increased our knowledge of the apparent angular diameters of giant stars, and given us a new and enlarged conception of the magnitude of the visible universe. On December 13, 1920, by the use of the Michelson interferometer, Pease found that the angular diameter of Betelgeuse, Arabic for the "Giant's shoulder," the conspicuous red star in the right shoulder of Orion, was 0″.047; and assuming a parallax of 0″.018, the linear diameter of α Orionis turned out to be 240,000,000 miles. To help us to understand what this means, we may say that the angular diameter of Betelgeuse is that of a ball one inch in diameter, seen at a distance of seventy miles. This giant star, which is but a tiny point of light to the naked eye, would completely fill the orbit of Mars; and if placed in the position of our sun would shoulder out the sky and we should see only a blazing firmament of fire. If a boy of fourteen were to fire around Betelgeuse a bullet with the unchanging velocity of 2,800 feet per second, the highest known velocity for a projectile, the bullet would not complete the circuit until he had reached the Biblical age of threescore years and ten. A ray of light from Betelgeuse, traveling at the rate of 186,330 miles per second, would take 160 years to reach us; which means that Betelgeuse is distant from the earth about one quadrillion miles.

In any attempt to measure the sidereal universe, it is necessary to increase enormously our units of measurement. In ordinary mensuration upon the earth, we employ the units: inches, feet, yards. In measuring the moon, on account of the great magnifying power of the modern lens, it is possible to use the mile as a unit. The next unit we resort to is the diameter of the earth—say some 8,000 miles. But in order to measure the distances from the sun to its attendant planets, it is necessary to use a unit 12,000 times the diameter of the earth—the *astronomical* unit —93,000,000 miles, the distance from the earth to the sun. But in order to measure the very great distances from star to star, which are as remote from each other in some cases as a thousand million astronomical units, it is necessary to use a still greater unit, the *light-year*. As light travels with the velocity

of about 186,000 miles per second, it is easy to compute the distance light travels in a year, which is something less than six million million miles. It is only by the use of such a yardstick as the light-year that one can satisfactorily take the scale of the sidereal universe.

While stars of the magnitude of Betelgeuse and Antares can be studied by the use of parallax methods, the globular clusters of the type of Omega Centauri and Hercules are so remote as to defy the astronomer in the attempt at determination of their distance from us by the geometrical measurement of parallax. By observing that, in each of the clusters where variable stars appear, the brightest stars of the cluster are, on the average, three times as bright, photographically, as the variables, Shapley has computed the distances from us of the principal globular clusters. Measuring the brightness of the brightest stars in any cluster, Shapley obtained results for some 30 clusters which are truly amazing. He found that the nearest of the globular clusters—Omega Centauri and 47 Tuscanae, both in the southern hemisphere—are distant from us about 22,000 light-years. The great cluster in Hercules is about 35,000 light-years away; and the remotest cluster, No. 7006, is at the enormous distance of 220,000 light-years—at least fifty times as far away as the remotest star whose distance can be measured by other methods.

Now our galaxy, delimitated for us by the projected contours of the Milky Way, is shaped much like a lens or a thin watch, the thickness being probably less than one sixth of the diameter. Astronomers are agreed that within this galaxy, which contains possibly a billion suns, the stars are not infinite in number nor uniform in distribution. Twenty years ago Newcomb remarked that the "sun *appears* to be in the galactic plane because the Milky Way is a great circle—an encircling band of light—and that the sun also *appears* near the center of the universe because the star density falls off with the distance in all directions." And yet he confesses: "Ptolemy showed by evidence which, from his standpoint, looked as sound as that which we have cited, that the earth was fixed in the center of the universe. May we not be the victim of some fallacy, as he was?" This very week, Painlevé, the distinguished French mathematician, made this extraordinary statement: "Under the old teachings it was explained that the world turned on its axis and in space. Of course, this is mere talk for children; no such thing occurs, but such explanations must be given so the ignorant can have a mental picture of what the universe is like. Neither the earth nor the stars whirl in space." Are we *all*, indeed, the victim of some strange fallacy?

To primitive man, the physical universe was anthropocentric. Eventually, with Ptolemy, came the conception of the geocentric universe. Since the time of Copernicus, astronomers have believed in a heliocentric universe—a universe in which the sun was considered to be at or near the center of the stellar universe. Shapley's investigations lead us to believe that the sun is at least 50,000 light-years from the galactic center. His study of the Cepheids—variable stars of short period named from the star Delta Cephei—have led to truly remarkable conclusions regarding the size and remoteness of these variable stars. They vary considerably in brightness from time to time, and also show corresponding alterations in color, being redder when faint, whiter when bright. Since spectroscopic observations of their motion in the line of sight show that the "peculiar" motions of these stars are unusually small, it was possible to devise trustworthy values for the average distance of these stars by considering their "parallactic drift" due to our motion in space past them. As the result of the observations of Russell, Hertzsprung and Shapley, it has been found that the average brightness of a Cepheid of period six days, is 750 times that of the sun; that a Cepheid with a period of 100 days is 23,000 times as bright as the sun; and that a Cepheid at maximum brightness is 30,000 times as bright as the sun. Computation on this basis shows that the Small Magellanic Cloud, one of the two remarkable outlying patches, similar to the Milky Way but remote from it, in the southern hemisphere, is at a distance from us of 62,000 light-years. A Cepheid of 100 days period is 800 times the sun's diameter—700 millions of miles—big enough to include all the inner planets of the solar system within its bulk, and almost as large as the orbit of Jupiter.

Shapley has calculated the actual positions in space of the 69 clusters definitely recognized as globular; and he finds that they, themselves, form a huge flattened cluster, probably 300,000 light-years in diameter, and about 100,000 light-years in thickness. "Since the affiliation of the globular clusters with the galaxy," says Shapley, "is shown by their concentration to the plane of the Milky Way and their symmetrical arrangement with respect to it, it also follows that the galactic system of stars is as large as this subordinate part. During the past year we have found Cepheid variables and other stars of high luminosity among the fifteenth magnitude stars of the galactic clouds; this can only mean that some parts of the clouds are more distant than the Hercules cluster. There seems to be good reason, therefore, to believe that the star-populated regions of the galactic system extend at least as far as the globular cluster."[2]

[2] *Bulletin of the National Research Council*, Vol. 2, part 3, No. 11: "The scale of the universe" by Harlow Shapley and Heber D. Curtis, 1921.

The center of this colossal globular star system is, according to Russell, some 70,000 light-years from the sun. The final conclusion, to which I would especially call your attention, is that, according to these truly arresting investigations, the diameter of the whole system of globular clusters is about the same as the diameter of the galactic system, namely, 300,000 light-years. This figure will, later on in this paper, furnish comparison with a remarkable investigation of Einstein regarding the size of the universe.

The largest figure hitherto given for the diameter of the galaxy was 60,000 light-years, advanced by Kapteyn. Other figures are Wolf, 14,000 light-years; Eddington, 15,000 light-years; Newcomb, 30,000 light-years. The new methods and the recent computations of Shapley, Hertzsprung, Russell and Miss Leavitt indicate a diameter for the galaxy some 10 times the figure ordinarily accepted by astronomers in the past. There appears, however, to be a definite limit to the size of the stellar universe. Stars of the second magnitude are 3.4 times as numerous as those of the first, those of the eighth magnitude are three times as numerous as those of the seventh, while the sixteenth magnitude stars are only 1.7 as numerous as those of the fifteenth magnitude. "This steadily decreasing ratio," says Hale, "is probably due to an actual thinning out of the stars towards the boundaries of the stellar universe, as the most exhaustive tests have failed to give any evidence of absorption of light in its passage through space."

Poets, philosophers, scientists throughout all the ages have regarded the universe as infinite. The book of Job gives us that awful image of an infinite void in the words: "He stretcheth out the north over the empty space, and hangeth the earth upon nothing." In propounding his doctrine of the infinity of the worlds in space, Giordano Bruno thunders out the mighty lines:

> Now unconfined the wings stretch out to heaven,
> Now shrink beneath a crystal firmament
> Aloft into the aether's fragrant deeps,
> Leaving below the earth-world with its pain,
> And all the passions of mortality.

On metaphysical grounds alone, Kant affirmed that space is infinite and is sown with similar stars in all parts.

Is the universe infinite? If a voyager of the skies travels in a straight line deep into the inter-stellar spaces, past the great blue helium stars of Orion, past Betelgeuse and Antares, beyond the white variable Cepheids, the gaseous red and yellow giant-stars, the colossal globular clusters, and beyond even the faintest of the super-nebulae whirling in fiery spirals in the dim void of remoter space—will he ever reach a limit of the sidereal realm? That is the profound and provocative query which has recently been raised anew by Einstein. In the Milky Way there are perhaps as many stars as there are now human beings living upon the earth. Beyond those dense masses of stars, such as the Magellanic Clouds, and beyond the great globular clusters which hover about the fringes of the Milky Way, lie vast wastes of desert space, devoid of stars over incalculable expanses. Beyond this, says Nordman, lie those strange bodies, the spiral nebulae, "lying like silver snails in the garden of the stars." Astronomers are divided in opinion to-day in regard to these spiral nebulae, of which there are known to be more than a million—whether to regard them as "island universes," systems like that of the Milky Way and comparable to it in their dimensions, or merely as annexes of the Milky Way, reduced models of it. These spiral nebulae have the enormous average space velocity of 1,200 kilometers per second; and their radial velocities and distribution, the maximum luminosity attainable by a star, the dimensions of our own galactic system, incline certain contemporary investigators to the hypothesis that the spiral nebulae are members of the galactic organization. Poincaré's calculation of the number of stars in the Milky Way agreed fairly closely with the number counted, which, taken together with other considerations, was opposed to an indefinite extension of the stellar universe.

What answer does the Newtonian mechanics give to the query: Is the stellar universe infinite? According to this theory, if there were an attenuated swarm of fixed stars of approximately the same kind and density, however far we might penetrate the interstellar spaces, then matter would have a finite mean density; and the intensity of the gravitational field at the boundary of the universe would be *infinite*—which is impossible. According, then, to the Newtonian theory, the mean density of matter must be infinitesimally small; and the cosmos must present the picture of an island of finite extent surrounded on all sides by infinite empty space. Such a view is repugnant to our minds, since the light of the stars and isolated stars themselves would drift away into the infinite, and this ephemeral cosmos would gradually melt away and disappear. Astronomical observation does not support the view that the energy of the cosmos is gradually being dissipated. To obviate these inevitable but incredible consequences of the Newtonian theory, it is necessary: either to assume with Seeliger, which is a purely *ad hoc* hypothesis, that the attraction of masses decreases at great distances somewhat more rapidly than in inverse proportion to the square of the distance; or else to assume that the number of stellar systems and stars is finite.

In a famous paper, "Cosmological Observations

Concerning General Relativity," published in the *Report of the Berlin Academy of Science,* February 8, 1917, Einstein advanced the view that the universe is finite, but unbounded. This statement sounds paradoxical, but brief reflection will show that a thing may be unbounded without being infinite. A being which moves on the surface of the earth, or indeed of any sphere, may travel over it indefinitely without ever reaching any boundary or limit. Similar considerations, extended to three-dimensional curved space, enable us to see how the universe may be at the same time finite and unbounded. Einstein assumed that the matter of the universe was distributed with uniform density; and that the stellar system is approximately at rest, since the velocity of the stars is very small as compared with the velocity of light. Assuming further the existence of pressure inside the electrically charged particles of matter in the universe, Einstein showed by elaborate calculations based on general relativity that space is "spherical" in structure, in the Riemann sense. In reality this means that space is "quasi-spherical" in the Riemann sense somewhat as the earth is quasi-spherical in the Euclidean sense, because of local corrugations. The Einstein universe is quasi-spherical, since matter does not actually occupy space uniformly and is not really at rest, but only shows the same density of distribution as a mean and has a very low velocity as compared with the velocity of light.

The "spherical" space here referred to is curved space—which means that according to Einstein the geometry of our universe is not Euclidean. The universe, moreover, does not have the shape of a sphere. It is not a three-dimensional space cut out of four-dimensional space—as is a sphere a two-dimensional space cut out of a three-dimensional space. It possesses the following properties: All lines starting from a point intersect again in the antipodal point measured along any of these lines. These straightest lines are closed and have a total length of $2\pi R$ where R is the "radius" of the universe. The greatest possible distance between two points is πR; and there is only one point, the antipodal point, at this distance from a given point. If a stellar body move through spherical space, its size gradually increases until it reaches its maximum at the universe's outer verge; and there, as it were, re-entering the universe it gradually diminishes in dimensions until it ultimately reaches its original size and position. Every point stands in the same relation to the rest of space as does every other point. There is no boundary to spherical space, and no center. The formula for the total volume of this spherical space is $2\pi^2R^3$.

Another extraordinary feature of this spherical space is that, neglecting the absorption of light, we should see a star-image of a given star at the opposite point in the heavens. If we look at some faint star in the Milky Way, the radiant pulses of energy give us a vision of the star, not as it is now, but as it was in the days of Tut-ankh-amen; and at the opposite point of the heavens we shall see an image of this same star—not as it was when the Egyptians were building the pyramids, but as it was perhaps in the prehistoric days of ancient Phoenicia. Who knows but that many of the stars we see in the firmament are not real but only ghosts of stars haunting the heavens from the days of remotest antiquity?

In this spherical space, according to Helmholtz, "we imagine the more distant objects to be more remote and larger than they are. But we find on approaching them that we reach them more quickly than we expected from their appearance. But we also see before us objects that we can fixate only with diverging lines of sight, *viz.,* all those at a greater distance from us than the quadrant of a great circle. . . . The strangest sight in the spherical world would be the back of our own head, in which all visual lines not stopped by other objects would meet again, and which must fill the background of the whole perspective figure." To those inclined to be sceptical of the existence or even of the conceivability of such a world, I need only suggest that you can see a world of spherical space by looking out at our own world through a slightly prismatic glass with the thicker side towards the nose.

In the graduate mathematics seminar at the University of North Carolina, we have made this year a thoroughgoing study of spherical space and the universe, according to Einstein's general relativity theory. The volume of this universe, expressed in grams, is 7 followed by forty-one ciphers, divided by the mean density of matter to the 3/2 power; and the mass of this universe is 7 followed by forty-one ciphers divided by the square-root of the mean density. If we assume that the average density of matter in the universe is the same as that of the Milky Way, we find that the radius of the universe is at least 150 million light-years; or, since the distance from the earth to the sun is 93,000,000 miles, the radius of the universe is 1 million times 10 million times the distance from the earth to the sun. Choosing the Milky Way as yardstick, of 30,000 light-years, according to the figure of Curtis, it will take 10,000 Milky Ways, laid end to end, to arrive at the diameter of the universe. The greatest sphere of water which could be included in the universe would have a radius of 300 million kilometers. Using the diameter of the earth's orbit as a measuring rod, we shall need 10 trillions of these units to take the measure of the diameter of the universe.

The weight of the universe, in grams, would be 1 followed by fifty-four ciphers—which would carry

us into the nonillions of grams. The weight of the Einstein universe bears the same relation to the weight of the whole earth as the latter bears to a kilogram. The weight of the earth to that of the sun is as 1 to 324,000. Hence we should have to take a trillion suns to get the weight of the universe.

It would take a ray of light, traveling at the rate of 186,000 miles per second, one billion years to go around the universe. To go around the universe it would take the fastest aeroplane 3 quadrillion years; the fastest automobile five and one half quadrillion years; and an express train, traveling at the rate of 60 miles an hour, 11 quadrillion years.

In conclusion, I wish to call your attention to the fact that the dimensions of this finite universe of Einstein are more than ample to include the spiral nebulae—whether regarded as galactic phenomena or even as island universes. On the assumption of approximate equality of size for celestial objects of the same class, which has been used by Shapley and other investigators, the extreme distance of the most remote of the spiral nebulae, considered as galactic phenomena, would be of the order of 10 million light-years; and, considered as island universes, would be of the order of 100 million light-years. Thus, even the most remote spiral nebulae would fall far within the bounds of the Einstein universe with its super-diameter of 300 million light-years.

Descartes, confronted with the question "What lies beyond?", always affirmed that a finite universe was impossible. This question has no meaning for Einstein because the foundation of general relativity is the doctrine that there is no space without matter or energy. If all the heavenly bodies we know belong to our galactic system, it is possible, says Einstein, that "other universes exist independently of our own." They may remain forever optically isolated from us by the phenomenon of the cosmic absorption of light. While other universes may palpitate beyond our own, no ray of knowledge, says Nordman, "could ever reach us from them. Nothing could cross the black, dumb abysses which environ our stellar island." We are doomed to dwell within a finite universe a thousand million times greater than the region now accessible to astronomical observation. Our glances are confined for ever within this giant—this all too minute—monad.

ARCHIBALD HENDERSON
THE UNIVERSITY OF NORTH CAROLINA

A NEW ERA FOR AMERICAN MUSEUMS

ON March 30, it was announced in SCIENCE that a grant of $30,000 had been made to The American Association of Museums contingent upon the raising of $55,000 more, and that the campaign for funds was expected to continue through the autumn of 1923. It is therefore a matter of pride to the association that announcement can be made now of the success of its project and of the consequent establishment of national headquarters at Washington, D. C.

This development signals the beginning of a new era for the association, of course, but much more than that, it is believed to mark the beginning of a new era for the museums of America.

Organization on a national scale to the end of maintaining a staff to work for a common cause has been found highly advantageous by local units in many fields. Most wide-spread interest has attached to industrial and commercial developments along these lines, but the same methods have been equally successful in fields of social, civic, religious and educational endeavor. The recourse by museums to organized cooperation is therefore not surprising, but it is a clear indication of the hopeful trend in museum affairs.

The funds now available have been contributed in part by individuals, many of whom are members of museum boards. Unfortunately no more than a dozen museum corporations have shared to any considerable extent in the financial burden, but it is hoped that the three-year demonstration, which is now assured of support, will bring about more general participation by museums. It is felt that the responsibility will have to be shared in equitable fashion by a majority of active museums before the movement can enter upon the road to permanent success. However, the work is now afoot, and the future will depend upon the success of activities during the next three years. For those who are most closely associated with the project, there is a great responsibility.

Fortunately there is no lack of interest and moral support on the part of museums—at least so far as official attitude can be judged by the consensus of opinion among some five hundred museum employees and trustees, who make up the active membership of the association.

The program which has been drafted looks far into the future, and there is no thought that more than a few of the most important projects can be initiated within the near future.

The Program

I. PROPAGANDA SERVICE FOR MUSEUMS.
To acquaint the American public with the work and aims of museums.
A. Press publicity—news items, articles and special departments in newspapers, magazines, trade papers and house organs.
B. Screen publicity—production and circulation of films and slides showing the value of museums; efforts to induce producers of educational films to utilize museum material.

C. Platform publicity—establishment of a board of lecturers made up of trained museum workers willing to give an occasional lecture for the association in places where such a lecture would help to stimulate interest in museums; lectures by the field secretary.

D. Exhibit publicity—participation in expositions to the extent at least of showing a traveling exhibit to convey the museum idea and to show the value of a museum to the community, to industry, to schools, etc.

E. Enlisting the active interest of communities and of various organizations with a view to inducing the establishment and development of museums in every community and of special museums under the auspices of industrial concerns and other organizations.

II. PUBLICATIONS SERVICE.

To make available the results of headquarters service, field surveys and research and to supplement the propaganda service.

A. Technical publications.

For museum workers and those intimately interested in museums.

1. Museum Work—a class periodical devoted to special articles, technical discussions, news of museums, proceedings of the association and items of current value with reference to association service.
2. Monographs — on museum principles and practice.
3. Museum Data—a loose leaf report service for members devoted to reference material.

B. Popular publications.

For the general public.

1. Special pamphlets—containing articles which may be useful in quantity to museums for the furtherance of such work as a membership campaign.
2. Popular magazine—to be established later for the purpose of supplementing the propaganda service.

III. LOCAL SERVICE IN FIELD.

To bring to any community the latest museum information from the entire country, particularly with reference to notable support of museums by their respective communities and the establishment of new museums.

A. Personal surveys by field secretary and recommendations concerning such matters as:

1. Membership.
2. Educational work.
3. Publicity methods.
4. Extension work—assistance in preparing plans for correlating museum educational programs with school curricula.

B. Personal assistance of field secretary in such matters as:

1. Membership campaigns.
2. Interviews with local authorities.
3. Talks at meetings.
4. Local publicity.
5. Establishment of museum councils—to consist of officials of museums in one community to secure effective coordination of effort.
6. Establishment of educational councils—to consist of officials of museums, colleges, schools, libraries and other educational institutions to secure a wise and correlated plan for the educational forces of a city.

IV. HEADQUARTERS SERVICE.

A. Clearing house between museums and organizations in allied fields.

To avoid duplication of effort and to make mutually available information concerning activities and services such as:

1. Lecturers and lectures.
2. Traveling exhibits.
3. Material for exchange and inter-loan.
4. Slides and films.
5. Expeditions and explorations.

B. Service bureau.

To perform for museums demanded services along lines covered by the clearing house and not already rendered by other organizations, until such time as an organization in the appropriate field may be induced to assume the service.

C. Information bureau.

To collect and to disseminate useful information and to foster cooperation and interchange of information between museums; report service to answer inquiries concerning such matters as:

1. Buildings.
2. Exhibition.
3. Administrative methods.
4. Educational methods.
5. Publicity methods.

D. Employment bureau.

To supply information concerning available or needed museum workers; to arrange for exchanges of staff members.

E. Cooperation with foreign associations of museums.

To foster international relations.

V. ADVANCEMENT OF MUSEUM SCIENCE AND PRACTICE.

To foster research and the training of museum personnel.

A. Research.

1. Study and analysis of museum problems and, if possible, formulation of general principles.
2. Effort to induce study of museum problems by research students and organizations.

B. Personnel training.

1. Studies and committee work to outline courses of undergraduate and graduate study in museumology.

2. Efforts to secure introduction of such subject matter into college undergraduate courses in education, art, history and science.
3. Cooperation with universities to establish graduate work in museumology.
4. Studies and committee work to outline training courses to be conducted in museums.
5. Efforts to secure establishment of such training courses in museums.
6. Vocational guidance for students and apprentices.

During the first year emphasis will be placed upon four undertakings. First, the bi-monthly publication, *Museum Work,* will be developed in order that the joined forces of museums may have a voice. Second, researches into museum principles and practices will be undertaken by the staff or will be set afoot through the good offices of other agencies concerned with museum problems. Third, an information bureau and service-center will be established at the Washington headquarters. Fourth, an effort will be made to modify in some degree the present misconception and inadequate understanding of museums which exists in the public mind. Beyond these four projects the trend of work will be influenced by expediency and the evolution of plans as time elapses.

THE STAFF

The new director of the association is Charles R. Richards, who until recently was director of Cooper Union. Professor Richards has already sailed for Europe, where he is to make a survey of museums with special reference to educational and economic service in the field of industrial art—a project which is being financed by the General Education Board, though it is to be carried forward in part as an association activity.

During the first year the secretary, who has become a resident member of the staff, is functioning as acting-director and will initiate the new inter-museum enterprise.

LAURENCE VAIL COLEMAN,
Secretary

SCIENTIFIC EVENTS

THE NUMBER OF MEDICAL STUDENTS

ACCORDING to statistics collected by the *Journal* of the American Medical Association, the total number of medical students in the United States for the year ending June 30, 1923, excluding premedical, special and postgraduate students, was 17,432, an increase of 1,292 over last year. This is the largest enrolment of students since 1912. Of the the total number of students, 16,771 were in attendance at the non-sectarian (regular) colleges, 341 at the homeopathic, 99 at the eclectic and 221 at the three nondescript colleges.

Medical College Attendance

Year	Non-sectarian	Total
1880	9,776	11,826
1890	13,521	15,404
1900	22,710	25,171
1901	23,846	26,417
1902	24,878	27,501
1903	24,930	27,615
1904	23,662	28,142
1905	24,119	26,147
1906	23,116	25,204
1907	22,303	24,276
1908	20,936	22,602
1909	20,554	22,145
1910	20,136	21,526
1911	18,414	19,786
1912	17,277	18,412
1913	15,919	17,015
1914	15,438	16,502
1915	13,914	14,891
1916	13,121	14,012
1917	12,925	13,764
1918	12,727	13,630
1919	12,259	13,052
1920	13,220	14,088
1921	14,033	14,872
1922	15,247	16,140
1923	16,771	17,432

During the past year there were 1,030 women studying medicine, the largest number since 1905, when there were 1,073. The percentage of women to all medical students this year is 5.9. There were 214

Women in Medicine

Year	Total Women Students	Percentage of all Students. Both Sexes
1904	1,129	4.3
1905	1,073	4.1
1906	895	3.5
1907	928	3.8
1908	835	3.7
1909	921	4.2
1910	907	4.2
1911	680	3.4
1912	679	3.2
1913	640	3.8
1914	631	3.8
1915	592	4.0
1916	566	4.0
1917	610	4.5
1918	581	4.3
1919	686	5.2
1920	818	5.8
1921	879	5.9
1922	989	6.1
1923	1,030	5.9

women graduates this year, 60 more than last year. Of all the women matriculants, 119 were in attendance at the one medical college for women, while 911 (88.4 per cent.) were matriculated in the 65 coeducational colleges. From the one women's college there were 21 graduates, while 193 (90.2 per cent.) secured their degree from coeducational colleges.

DISCUSSION ON ORGANIC ELECTROCHEMISTRY

OF particular interest to the electrochemist is the announcement of a round table discussion on organic electrochemistry to be held during the fall meeting of the American Electrochemical Society, in Dayton, Ohio, on September 27, 28 and 29. Professor Charles J. Thatcher will preside over the discussion.

The topics selected for discussion are:

1. *The Present Status of Organic Electrochemistry:*
   This will comprise consideration of the Organic compounds now manufactured electrochemically, here and abroad, and the advantages of the electrolytic methods.
2. *The Future Development of Organic Electrochemistry:*
   Discussion under this topic will comprise:
   A—Enumeration of the Organic compounds which have been or are being investigated with a view to commercial production and announcement of forthcoming papers regarding such investigations.
   B—A consideration of the more serious difficulties encountered, generally, in development of electrochemical processes for the manufacture of organic compounds, and of means whereby these difficulties may be overcome. This topic should bring out opinions as to the better type of cell and diaphragm for acid and alkaline electrolyses, and whether non-diaphragm cells are practical.
   C—Discussion of fields for research and industrial developments and announcements of intended investigations to avoid duplication of work.

All members who are unable to be present at this discussion are invited to send in written communications which they desire read at the discussion, to the chairman of the committee, in care of the secretary of the society. There will be no stenographic record taken at this discussion.

THE LAKE STATES FOREST EXPERIMENT STATION

THE last session of the Congress appropriated $50,000 for the establishment of two new forest experiment stations, one in the Northeast and one in the Lake States. The headquarters of the Northeastern Station has been established at Amherst, Mass., in cooperation with the Amherst Agricultural College. The headquarters of the Lake States Station will be in St. Paul, in cooperation with the University of Minnesota. This will be a regional station to take care of the forest problems arising in the Lake States region.

The projects of this station will include studies in reforestation, management, methods of cutting, slash disposal and other phases of forest growth and protection. Mr. Raphael Zon has been selected as the head of the new station.

Mr. Zon has been connected with the research work of the U. S. Forest Service for 22 years. He is editor of *The Journal of Forestry*, chairman of the Forestry Committee of the National Research Council, and is one of the veterans of the forestry profession in this country. He was graduated from Cornell University in 1901 and was the second forester to be graduated in the United States. He has always been especially interested in research problems; it was he who first started the experiment station idea in this country, and probably contributed more than any other forester to the development of the science of forestry. For many years forestry in the United States was entirely on an empirical basis. The Lake States Forest Experiment Station, and such other stations of the same character as the government has established and may establish in other places, is intended to assemble the necessary facts to place forestry on a firm scientific foundation.

Mr. Zon is already on the grounds and will soon be joined by four other members of his technical staff—J. A. Mitchell, Jos. Kittredge, H. Grossman and A. E. Wackerman.

E. G. CHEYNEY

INSURANCE OF THE RESULTS OF AN ECLIPSE EXPEDITION

ACCORDING to press reports a policy of $10,000 against failure through weather conditions has been taken out by the Swarthmore University expedition to Yerbaniz, Mexico, where on September 10 photographs of the sun's eclipse will be taken.

This is said to be the first time that a scientific expedition has been insured. The policy was obtained by George H. Brooks, a Swarthmore alumnus, through the Home Insurance Company. The premium is $500. It is doubtless the shortest term policy ever issued by a company, since it remains in force for two minutes and fifty-nine seconds, the time during which it will be possible to photograph the eclipse.

Explaining the decision of Swarthmore University to protect the expedition against the elements, Mr. Brooks wrote to the insurance company:

The photographs of the solar eclipse taken by the expedition, which is under the leadership of Dr. John A. Miller of Swarthmore University and head of the Sproul

observatory, will be of incalculable value to science if they can be secured. To equip such an expedition as this requires a large sum of money, and there is an ever present possibility of failure at the last moment should atmospheric conditions at the time be such as to affect the visibility and to make the taking of the photographs an impossibility.

To compensate for possible loss of time and money, and to enable future expeditions to carry on the work with the same funds until they are rewarded with success, the Swarthmore expedition desires to go to Mexico armed with insurance against those conditions over which they have no control.

The policy, which is written under the rain insurance form, provides:

If by reason of weather conditions affecting visibility only, or by vibration of instruments caused by winds in the State of Durango, Mexico, on Sept. 10, 1923, between 2:34:17 P. M. and 2:37:16 P. M., or thereabouts, standard time, the insured is prevented from taking photographs of scientific value of the eclipse of the sun, then this company shall be liable for and shall pay the amount set forth in the schedule below.

The schedule sets forth the description of the cameras used and the number of plates to be exposed. The policy provides further that the determination of the scientific value of the pictures shall be left to Professor George H. Peters, of the United States Naval Observatory, Washington, D. C. His findings are to be conclusive and binding upon both parties.

THE LIVERPOOL MEETING OF THE BRITISH ASSOCIATION

THE ninety-first annual meeting of the British Association will be held at Liverpool from September 12 to 19. According to the London *Times* it promises to be larger than any of its predecessors, it being expected that between 3,000 and 3,500 persons will attend, of whom about 1,500 will be visitors. The last meeting in Liverpool was in 1896, when Sir Joseph Lister was the president. This year Sir E. Rutherford occupies that position, and the subject of his address will be the "Electrical structure of matter." There are thirteen sections, and five addresses by their presidents will be delivered on September 13, five on September 14 and three on September 17.

It has been the rule at many previous meetings for the British Association to devote particular attention to some branch of scientific study relevant to the town which it is visiting. Last year, at Hull, sea fisheries formed the subject for consideration; and this year geologists and geographers are making a special feature of subjects which are of local interest to Liverpool and district. Professor P. G. H. Boswell will open a discussion at the first meeting of the geological section on the "Geology of the Liverpool District," and Sir A. Strahan, ex-director of the Geological Survey, will discuss the "Geography of the Liverpool District from Pre-Glacial Times to the Present"; while in the geography section papers on "The Region around the Mersey and Dee Estuaries" will be submitted by Mr. W. Hewitt, Mr. H. King and Mr. K. C. Moore.

The association will be strong this year in the attendance of foreign representatives. Ten or a dozen leading Canadian scientists are going, and their presence may be regarded as having particular reference to the meeting of the association next year at Toronto and the arrangements that will be made by the general committee in relation thereto. There are altogether about thirty foreigners expected, mostly French and Danes. Among them are Professor Langevin, of Paris; Signor Conti, of Florence; Dr. Coster and Dr. Henesy, of Copenhagen; Dr. Roule, Paris; Professor Jesperson and Professor N. Bohr, of Copenhagen.

An addition to the program is an address by Dr. F. W. Aston, of Cambridge, who gave an "Atomic theory" lecture last year at Hull, on new matter which has been the result of his past year's work. In the Engineering and Psychology Sections discussions will take place on "Vocational tests for engineering trades." Afternoon meetings are said to be becoming a feature of increased importance. The committee has found that these fixtures are appreciated, and they have been fixed, therefore, for 5 o'clock, because people who cannot attend the meetings of the association during working hours can be present at that hour. These addresses will be given by Dr. G. H. Miles on "Vocational Guidance"; Dr. C. S. Grundy on "Teaching Music to Children," with an orchestral demonstration; Dr. Schmidt on "The Dana expeditions and their work on the life-history of the eel."

On Tuesday evening, the eighteenth, a scientific *soirée* will be given at the Liverpool University. This is a new feaure, and is on the lines of the Royal Society's *soirées* in Burlington House, Piccadilly, with demonstrations and short lectures. Another feature is the scientific exhibition, which will be run by the Liverpool authorities, at which a large number of scientific instrument makers will be the exhibitors.

SCIENTIFIC NOTES AND NEWS

THE Pan-Pacific Scientific Congress, in which fourteen nations are represented, was opened at Melbourne on August 13, with the presidential address by Sir David O. Masson.

DR. EDGAR F. SMITH, provost emeritus of the University of Pennsylvania and past-president of the American Chemical Society, has been made an Officer of the Legion of Honor of France. The insignia

and brevet have been transmitted to him through the French Embassy at Washington.

DR. ARTHUR A. NOYES, director of the Gates Chemical Laboratory of the California Institute of Technology, has been elected an honorary fellow of the Royal Society of Edinburgh. There are fifty-seven honorary fellows of the society, seven of whom are Americans, of these a majority are from the Pacific coast, namely, in addition to Dr. Noyes, William Wallace Campbell, president of the University of California and honorary director of the Lick Observatory; George Ellery Hale, honorary director of the Mt. Wilson Observatory; Douglas H. Campbell, professor of botany, Stanford University. One of the other three members, Dr. Albert A. Michelson, professor of physics at the University of Chicago, is also research associate of the Mt. Wilson Observatory and the California Institute of Technology.

THE delegates to the forty-seventh meeting of the French Association for the Advancement of Science included Dr. Gerson, from the British Association; Sir William Pope, from the University of Cambridge; Dr. Aleš Hrdlička, of the U. S. National Museum; M. Carracido, rector of the University of Madrid; Professor Pittiard, of Geneva, and M. Boccardi, director of the observatory at Turin.

PROFESSOR EHLERS, of Copenhagen, the authority on leprosy, has been nominated honorary professor of Strasbourg University.

THE title of professor has been conferred by the faculty of science of the University of Paris on MM. Julia, mathematics; Maugain, mineralogy; Blaringhem, botany, and Michel-Levy, petrography.

AT the meeting of the council of the Royal College of Surgeons of England on July 12, Sir John Bland-Sutton was elected president in succession to Sir Anthony Bowlby, who had held that office for three years. Sir Berkeley Moynihan, Bt., professor of clinical surgery in the University of Leeds, and Mr. H. J. Waring, surgeon to St. Bartholomew's Hospital and vice-chancellor of the University of London, were elected vice-presidents.

DR. RAOUL GAUTIER, director of the Observatory and professor in the University of Geneva, Switzerland, has been elected to honorary membership in the Washington Academy of Sciences in recognition of his prominence in geodesy and his intimate connection with scientific work in Washington.

M. JEAN BOSLER, assistant astronomer at the Paris Observatory, has been appointed director of the observatory at Marseilles in the place of the late M. Bourget.

DR. C. ROBERT MOULTON, previously head of the department of agricultural chemistry in the University of Missouri, has been appointed director of the bureau of nutrition of the American Meat Packers Association. Miss Gudrum Carlson, formerly of Teachers College, assumes direction of the bureau of home economics.

C. J. ALBRECHT, curator of zoological exhibits at the University of Washington, has been appointed first assistant to the chief of museum exhibits at the American Museum of Natural History of New York City.

DR. V. L. BOHNSON has resigned as assistant professor of chemistry at the University of Wisconsin, to join the staff of the Oldbury Electrochemical Company, Niagara Falls, N. Y.

THE American Public Health Association will make an annual award to the city of one hundred thousand population or over that can show the most nearly adequate community health service by January, 1924, and the most progress after that date, according to statements made in the daily papers. The committee, consisting of Professor C. E.-A. Winslow, of Yale; Dr. Donald B. Armstrong, Professors Freeman and Frost, of Johns Hopkins, and Dr. L. R. Thompson, of the U. S. Public Health Service, will have the matter in charge in cooperation with the Metropolitan Life Insurance Company.

DR. ALLER G. ELLIS, formerly associate professor of pathology at Jefferson Medical College, Philadelphia, has sailed for Bangkok, Siam, where he will take charge of the pathological department of the Royal Medical College, Bangkok, under the auspices of the Rockefeller Foundation of New York.

WE learn from the *Journal* of the Washington Academy of Sciences that Mr. W. E. Myer, of the Smithsonian Institution, has returned from Tennessee where he has been excavating the Great Mound Group in Cheatham County. He found traces of an important ancient town covering 500 acres in two adjoining bends of Harpeth River. Many earth-lodge sites were excavated which yielded a considerable amount of information as to the life of the former inhabitants.

STEPHEN PASCHALL SHARPLES, consulting chemist, died at Deer Island, Maine, on August 20, at the age of eighty-one years. Mr. Sharples was known for his research on the adulteration of foods and on rubber. He was a fellow of the American Academy of Arts and Sciences and of the American Association for the Advancement of Science.

DR. JAMES LEONARD CORNING, the neurologist, known for the discovery in 1885 of spinal anaesthesia, died on August 25 at Morristown, N. J.

DR. MICHAEL P. C. POTVLIET, chief chemist of the Dominion Sugar Company, died on August 3, aged fifty-seven years.

THE bodies of Sir Henry Hubert Hayden, director of the Geological Survey of India, and his two guides, who left Lauterbrunnen, August 10, for an excursion up the Jungfrau, were found on August 30 on the west base of the precipice on the Finisteraarhorn.

THE centenary of the death of Brégnet will be commemorated at the Congress of Chronometry to be held at the observatory of the Sorbonne. There will be an exhibit of his works and of instruments designed by Brégnet and his son Antoine in the gallery of the museum from October 25 to November 24. An international exhibit of chronometers will be organized in September at Neuchâtel.

PROFESSOR GOLDSCHMIDT writes from Berlin under date of July 25: "The readers of SCIENCE might be interested in the following item: To-day the Prussian Academy of Science voted this year's research grants. I have added to each its value in gold at to-day's rate of exchange: Professor Guthnick for thermo-electric measurements of stars, 100,000 marks = 22 cents; Professor Pompecky for his work on the Tendagusu fossils, 80,000 marks = 18 cents; Dr. F. Leng for his work on the physiology of cell-division, 20,000 marks = 4 cents. The highest award is for work on Egyptian texts, 500,000 marks = $1.11. Further comment seems unnecessary."

THE Rockefeller Foundation has arranged to present to the German universities five copies each of the principal British and American medical journals. One copy will be given to the State Library of Berlin or Munich and the other four will be distributed among four groups in the north, south, east and west of Germany, each of which contains five or six universities. A journal will remain in the library of each university for two months.

THE Insulin Committee, recently organized to provide free insulin treatment for diabetics of New York City unable to pay for treatment, has announced the receipt of $2,500 from the New York Foundation; $2,500 each from the Hofheimer Foundation and Felix M. Warburg; $1,000 each from Marshall Field III, J. J. Wyle and Mrs. J. J. Wyle; $500 each from Frederick Strauss and Mrs. Jacob H. Schiff, and $250 each from Ellen C. Auchmuty, Jules S. Bache, Norman Goldman, John L. Wilkie and E. F. Albee. The treatment at present approximates $1.20 per day for each patient.

THE Intellectual Cooperation Commission of the League of Nations decided on July 29 to submit to the Council and to the Assembly of the League, a draft Convention for the Protection of Scientific Discoveries, drawn up by Professor Ruffini. In submitting this draft convention the commission is asking the governments to establish for scientific discoveries a copyright similar to that granted for literary and artistic work. With a view to helping towards the organization of intellectual societies, the commission advocates the creation of national commissions of intellectual cooperation, similar to those which already exist in various countries.

DELEGATES from the French Confederation and from five foreign countries (Belgium, Bulgaria, Finland, Great Britain and Switzerland) met recently in Paris and established the International Confederation of Intellectual Workers. The secretary has been empowered to draw up a constitution and by-laws, which will be sent for examination to the national confederations and will be submitted at the December session of the international body. The principal subjects for discussion at this session are: intellectual property (recognition of such property in all countries in which it is not yet recognized; its protection), and the creation of scientific property.

THE British Minister of Health has appointed a committee to inquire into the use of preservatives and coloring matters in food and to report (1) whether the use of such material or any of them for the preservation and coloring of food is injurious to health, and, if so, in what quantities does their use become injurious; (2) whether it should be required that the presence of such materials and the quantities present in food offered for sale should be declared. The committee is constituted as follows: Sir H. G. Monro, Professor W. E. Dixon, Sir A. D. Hall, Dr. J. M. Hamill, Mr. O. Hehner, Professor F. G. Hopkins, Dr. G. R. Leighton, Dr. A. P. Luff, Dr. C. Porter and Mr. G. Stubbs. The secretary of the committee is Mr. A. M. Legge, of the Ministry of Health.

THE Belgian government has granted a subvention to Professor M. Stuyvaert, of the University of Ghent, for the publication of his *Méthodologie mathématique*.

THE British Medical Research Council announced that it has awarded Rockefeller Medical Fellowships, tenable in the United States of America during the academic year 1923–1924, to the following: John Crichton Bramwell, medical registrar and registrar to the cardiographic department, Manchester Royal Infirmary. Norman McOmish Dott, assistant in the physiological department, University of Edinburgh. Helen Ingleby, assistant physician, Victoria Hospital for Children and South London Hospital for Women. Hugh Kingsley Ward, member of the scientific staff of the Medical Research Council, and working in the department of Pathology, University of Oxford. It is understood that further awards may be made during the coming academic year.

UNIVERSITY AND EDUCATIONAL NOTES

ON the completion of the state general hospital now under construction at a cost of $1,400,000 at the University of Wisconsin, the university plans a four-year course in medicine. The new hospital will have 300 rooms, twelve large wards and facilities for medical students to serve internships.

THROUGH an exchange agreement between Stanford University and Colorado Agricultural College, Professor Geo. T. Avery will take advanced work at Stanford the coming year.

PROFESSOR ROY G. COFFIN has been promoted to an associate professorship of chemistry in the Colorado Agricultural College.

DR. CHARLES H. DANFORTH has been promoted to full professorship in the department of anatomy at Stanford University School of Medicine.

DISCUSSION AND CORRESPONDENCE

WHAT IS WRONG?

ONCE upon a time, a fable tells us, a bull, observing with pleasure the joyous frolics of some frogs, tried with the best intentions to assist in the sport, but the attempt was a failure. The unappreciative frogs cried out—"It may be fun for you, but it is death for us," and the bull withdrew, bewildered and disconsolate.

Some of us, engaged in research in industrial laboratories, may share the disappointment and bewilderment of the poor bull. We study with pleasure, profit and admiration the work of American research men in academic circles. We hope that our work in turn may benefit them, and to that end we freely publish our results. We even try in many ways to give direct assistance. We seek to strengthen the hands of our brother scientists and to earn their good will.

And now we are told by a very able man that we may be swallowing up "the soul of the university" (Dean Barus in the annual report of the president of Brown University, SCIENCE, April 13, 1923). We are crowding with our papers "the programs of the meetings of American learned societies." We are crushing "the incentives to a stimulating competition."

Dean Barus administers his rebuke in delightfully whimsical but earnestly forceful words, and, like the bull in the fable, we pause, disappointed and abashed, and ask—"What is wrong?"

Is there some corporate stigma we carry that makes us unfit companions in the cooperative study of Nature? Are we, too, branded with that "potent cipher," "PAT," which Dean Barus finds marking the trail of "the trusts, as we fondly call them"? The industrial applications of our research may be patented, but we hope the new scientific facts we may discover will be without taint and of benefit to all scientific workers. Are we wrong in that?

Or is it the greater facilities of our laboratories, which, like the bull's avoirdupois, crush competition and overwhelm the professor's soul? If that is the trouble, what is the remedy? If the object of the competition were no more important than a golf championship, the Schenectady putter might perhaps reasonably be barred, as it is barred in England, in the interest of sport, but, in a game in which the object is the increase of human knowledge, an arbitrary limitation of implements would seem too extreme a concession to the sporting instinct. Would it not be better to put the best implements in the hands of all who could use them effectively?

And that, in a modest way, is precisely what we are trying to do. We are not wholly what the Old Soak calls a "mammal of unrighteousness," but if we were, our selfish interests would still insist on our helping academic research as far as we can, since what we, like the rest of the world, most need, and what is far more important to us than material equipment, is men, men with minds trained in scientific methods and filled with a sanely balanced enthusiasm for research. For this prime essential we must look to the universities, and we fully realize that only a vigorous spirit of research in the professor can awaken the spirit of research in the student, and that the spirit of research in the professor can be sustained and quickened only if he and his assistants are given time and facilities for advanced scientific work.

We keenly desire to help. If we are properly advised can we not really help?

Why can not a mutuality of interest and good will be developed between the workers in industrial and academic laboratories? We have tried to hasten such a development. Are we failing? If so, what is wrong?

W. R. WHITNEY
L. A. HAWKINS

RESEARCH LABORATORIES OF GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

AN ANCIENT REFERENCE TO AIRSHIPS

THE suggested existence of airships in early days is found in a book published in 1922 by the Medici Society of London, "The Queen of Sheba and her only Son Menyelek," etc. This book is a translation of the "Kebra Nagast," with introduction by Sir E. A. Wallis Budge; the date of which manuscript Budge assigns to the sixth century, A. D., and the compila-

tion to probably "a Coptic priest for the books he used were writings that were accepted by the Coptic Church" (p. VIII).

The "'Kebra Nagast,' *i.e.*, The Glory of the Kings [of Ethiopia] has been held," says Budge, "in peculiar honour in Abyssinia for several centuries and throughout that country it has been, and still is, venerated by the people as containing the final proof of their descent from the Hebrew Patriarchs, and of the kinship of their kings of the Solomonic line with Christ, the Son of God." The book is "a great storehouse of legends and traditions, some historical and some of a purely folklore character, derived from the Old Testament and the late Rabbinic writings, and from Egyptian (both pagan and Christian), Arabian and Ethiopian sources" (pp. VII–VIII).

The reference to an airship follows the well-known incident of the visit of the Queen of Sheba to King Solomon, who, on the departure of the queen to her own country, gave her, among other fabulously valuable gifts, "a vessel wherein one could travel over the sea and a vessel wherein one could traverse the air (or winds) which Solomon had made by the wisdom that God had given him" (pp. 36–37), thereby, as Budge has pointed out, anticipating "the motor boat and the airship." As ordinary sailing vessels were certainly in use by the time of Solomon it is hardly probable that a vessel of either the galley type or of the sail type would be regarded as of any especially marvelous character. Budge apparently does not note the possible fact that King Solomon understood the construction of artificial lights suggesting modern incandescence, inasmuch as his (Solomon's) house "was illumined as by day, for in his wisdom he had made shining pearls which were like unto the sun, and moon and stars [and had set them] in the roof of his house" (p. 34). All of which would seem to indicate that life in the Solomonic days, save for a certain laxity in morals, was as comfortable and convenient as in the present.

ALICE ALLEN EHRENFELD
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A FOURTH CAPTURE IN FLORIDA WATERS OF THE WHALE SHARK

ABOUT 11 o'clock on the morning of June 9, 1923, as Mr. Claude Nolan, of Jacksonville, Florida, was cruising with a party of friends in the Florida Keys near Marathon, sixteen miles below Long Key, a gigantic shark was seen. This was secured by two harpoons by Captain Newton Knowles, who later fired into it fifty or sixty shots from a 30–30 rifle. The giant fish did not offer much resistance and by the afternoon it was so far subdued that it was towed by a house-boat and two guide-boats to Long Key, where it was tied up to the dock about 11 P. M. The fish remained alive until some time the second day, following, about fifty-four hours after it was harpooned.

Mr. L. L. Mowbray of the New York Aquarium by great good fortune was in Florida at this time. He had gone to Nassau, Bahamas, to install an aquarium there, but, finding the water in the harbor fouled by the dredging going on, left for Miami, where he arrived on the morning of June 9. Early the next day, hearing of the capture of a "huge monster" at Marathon, he took the first train for Long Key, and at once identified the fish as the whale shark, *Rhineodon typus*.

Mr. Nolan with great generosity presented this giant shark to the American Museum, and Mr. Mowbray at once wired the authorities. A member of our department of preparation left at once for southern Florida with orders to save the skin and all the hard parts possible. In the meantime Mr. Mowbray had advised that there were no facilities for handling the shark at Long Key and urged that it be towed to Key West. This was accordingly done, the start being made June 13, and the fish arriving at Key West at 4:30 P. M., June 14, much mauled by the attacks of tiger sharks on the way.

Unfortunately a wave of unprecedented hot weather struck southern Florida at this time, and the water in Key West harbor reached the unheard-of temperature of 91.4° F. This, aided by the fact that some of the fins had been torn off and the abdomen badly lacerated by sharks, produced rapid decomposition. The outer skin sloughed off, the internal organs were thoroughly macerated, and even the solid masses of thick, muscular tissue were in such condition as to call for immediate action. It was impossible to save the skin, but various hard parts were preserved in brine and brought to New York. We have parts of a tooth band, the cartilages of both jaws, the occipital part of the skull, a number of vertebrae, and parts of the claspers, and, in addition, sections of the skin.

Mr. Mowbray fortunately made a sketch of the shark and a set of careful measurements, and wrote out an exact description, noting position, size and shape of fins, coloration, etc. From these data a 63-inch model is now being constructed by our department of preparation. This will be molded and colored in accordance with Mr. Mowbray's notes, and can serve as a basis for building a life-sized model for our new hall of fishes. The fish was 31.5 feet long, 23 feet in greatest girth, and had a vertical spread of caudal fin of 12 feet. Mr. Mowbray and the writer plan to write for the *Bulletin* of the American Museum a fuller article on this specimen, illustrated by photographs of the fish and of the completed model.

This is the fourth specimen of Rhineodon recorded from the Florida coast, and the fifth in the Atlantic

Ocean. The first specimen, 18 feet in length, came ashore on Ormond Beach in 1902. The second, a 38-foot specimen, was taken by Captain Charles Thompson of Miami and Mr. Charles T. Brooks of Cleveland, Ohio, in May, 1912. The third (31 feet long) was captured by Dr. H. Schlegel and others in the Bay of Florida, June 10, 1919, and the fourth (31.5 feet between perpendiculars) is the present specimen. The fifth record for the Atlantic is the specimen (about 30 feet long) rammed by the steamship *American Legion* in May, 1922, near the Abrolhos Light off the coast of Brazil, and noted by me in SCIENCE, 1922, Vol. 66, pp. 251–252, and in *Natural History*, 1923, Vol. 23, pp. 62–63.

E. W. GUDGER
AMERICAN MUSEUM OF NATURAL HISTORY

QUOTATIONS

MEDICAL RESEARCH

SIR,—In your issue of the 7th a patient points out in a very vivid letter the benefits, dangers and costliness of insulin in his own case of diabetes. He shows clearly that it is impossible to continue its use indefinitely, and when discontinued that the diabetes returns with death as the unavoidable result. This demonstrates conclusively the need for one thing—the discovery of the real cause of diabetes, and this can only be attained by experimental research.

The key to the discovery of insulin was Minkowski's demonstration in 1905 that every dog from which the pancreas (the sweetbread of our dinner table) was removed died of diabetes. Evidently there was something in the pancreas which prevented the disease. Banting and Best discovered that something. But that discovery still leaves us in the dark as to what is the disturbance of nutrition—the metabolism of the body—which prevents the burning up of the sugar in the blood. This accumulation of sugar inevitably causes death, slowly in most adults, swiftly in children.

It is perfectly evident to any open-minded person that the discovery of the cause of this disturbance of the nutrition in the body cannot be made simply by clinical observation on man. It can only be obtained by experimental research on animals. This is a duty imposed upon our research workers. Any obstacle put in their way is deliberate cruelty to human beings, and not to a small number of human beings, but to a very large number, especially of children.

When the alternative of experimenting on animals or of allowing multitudes of human beings to die of diabetes is presented to any unprejudiced mind, there can be but one answer. The lives of human beings are of infinitely more value than those of animals. Moreover, once the cause is discovered, the lives and happiness of human beings and their families are conserved for all future time. The sacrifice of a relatively few dogs sinks into insignificance in comparison with the lives and happiness of multitudes of human beings.—*W. W. Keen, in the London Times.*

SCIENTIFIC BOOKS

A classification of fishes including families and genera so far as known. By DAVID STARR JORDAN, Chancellor Emeritus of Stanford University. Stanford Univ. Publ. (Biol. Sci.), Vol. 3, No. 2, 1923, pp. 79–243, i-x.

UNTIL the appearance of the work cited, ichthyologists had long waited for a comprehensive classification of all the known genera and families of fishes. Not since the publication of Günther's "*Catalogue of the fishes of the British Museum* (1859 to 1870)" had any one attempted to supply this need. The work of Günther had been a long and tedious one, having required for its completion a considerable part of the lifetime of one of the most laborious of systematic zoologists. Furthermore, the knowledge of ichthyology had since that time been greatly widened in many ways.

The task of preparing a new classification year by year had thus become increasingly large and difficult: so much so, in fact, that Dr. Jordan alone among living workers possessed a knowledge of the literature of ichthyology which was sufficiently comprehensive and an acquaintance with the fishes of the whole world intimate enough to permit of the preparation of such a work.

In this latest classification, fishes, living and extinct, are arranged under six classes: Leptocardii, Marsipobranchii, Ostracophori, Arthrodira, Elasmobranchii and Pisces. The "true fishes" are further divided into three subclasses: Crossopterygii, Dipneusta (Dipnoi) and Actinopteri. The Actinopteri are made to include the superorders Ganoidei, Teleostei and Acanthopterygii (the author, however, certainly did not intend to remove the group last named from nor to coordinate it with the Teleostei). The teleost fishes are divided into no fewer than 39 orders, the increase being largely accomplished by the elevation of various groups, largely the serranoid derivatives, from subordinal to ordinal rank.

Space will not permit of the discussion, or even an outline, of the limits and positions assigned to these various groups. As a whole Dr. Jordan has followed recent suggestions regarding the status of the major groups of fishes.

There is widely used throughout the work, particularly among the "higher" fishes, a group termed the *series*. Usually but not consistently the names of series are formed by adding the suffix *-iformes* to the root of the typical genus of the group. In most cases

the series are used as strictly or approximately coordinate with suborders, but once a series (Ostariophysi) is used to include several orders, while in a few instances series are subordinated to suborders.

The most striking taxonomic feature of the whole work—one which will appeal to many systematists as radical—is the extreme multiplication of family divisions. In all, the fishes are divided into 638 families; the teleosts alone are split into 511; the current group Cottidae, to take an example, is analyzed into 12 families. The increase in the number of families has been brought about by the entire elimination of subfamilies, those less sharply marked being merged together, those more clearly defined elevated to family rank.

This minute division of fishes into families is justified by the statement, often used by the author, "that analysis must precede synthesis." It must be remarked, however, that in actual practice analysis seldom has led to synthesis. To use more familiar terms, "splitting" leads to further "splitting," not to "lumping."

It seems impossible to arrive at any conclusion as to whether this multiplication of families is or is not justified. There is no known clear-cut criterion by which to decide whether any natural assemblage of genera should be called a subfamily or a family, or a "series" or suborder. There is, as indeed the present work strongly suggests, a very large if not a preponderating element of the subjective in the estimation of taxonomic rank.

Under each family the pertinent generic names, with authorities and dates, are listed chronologically. With each name is given a page reference to "The genera of fishes," which was published by the same author, in four parts, from 1917 to 1920. That work and "A classification of fishes" will for many years be two of the most used of any works in the libraries of systematic ichthyologists.

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SPECIAL ARTICLES

BLACKENED SPHERES FOR ATMOMETRY

SINCE the time when spherical, white, porous porcelain pieces first became available for use in the study of evaporation as one of the influential environmental conditions affecting organisms, it has been clear that black, porous spheres, as well as white ones, are much needed in ecological and physiological instrumentation. Two porous-cup atmometers operating side by side, one equipped with a white and the other with a black sphere, the two spheres being practically alike in all respects excepting as to their ability to absorb radiation, constitute what I have called a radio-atmometer. Rates of water loss from the black member are greater than the corresponding rates of loss from the white during periods of illumination, while both members lose water at the same rate in darkness. The difference between the two rates for any period constitutes a valuable index of the intensity of radiation for that period. The radio-atmometer has already established itself as a valuable instrument in the hands of research workers interested in natural solar radiation as the latter influences the growth of plants, and especially as it accelerates the rate of water loss from their foliage.

Although a supply of rather satisfactory black, porous porcelain spheres was secured several years ago, the supply has recently become exhausted and it will probably be a number of months before another supply will become available, for serious difficulties are encountered in the making of these black pieces. In the *interim* I have tried several proposed methods for blackening the ordinary white spheres. The black materials that can be readily applied to such pieces are subject to removal by the action of rain or else, if they adhere well, they often tend to reduce the water-permeability of the porous porcelain. I have recently employed a coating of lampblack with excellent results in instrumentation wherein rain is not encountered. For rainless periods in the open and for greenhouse studies, these lampblackened spheres are more satisfactory in operation than are any black porcelain spheres thus far secured. The purpose of this note is to bring this simple blackening of the white spheres to the attention of those who wish to employ radio-atmometers for studying solar radiation, etc., in exposures where rain does not occur or for periods without precipitation.

Commercial lampblack is first thoroughly washed by repeated boiling in distilled water, the liquid being thoroughly stirred as it boils. After each boiling it is allowed to settle and most of the water is decanted off, a new supply of water being then added for the next boiling. Four or five boilings and decantings result in a material that settles readily in water and exhibits no oily film. The washed lampblack is preserved under distilled water in a stoppered bottle. It is applied to the porcelain sphere, after the latter has been filled and set up for operation, by means of a small camel-hair brush. The excess of water enters the sphere, leaving a uniform layer of wet lampblack on the outer surface. The black coating remains wet with the highest rates of evaporation and the most intense sunshine, it does not significantly alter the evaporation coefficient of the sphere, as far as conditions other than radiation are concerned, and it acts very satisfactorily as an absorber of radiation. The sphere should be cleaned and recoated about once a week—or oftener if the prepared surface is accidentally in-

jured, as by the innocent fingering of the ubiquitous meddling visitor or by rain. Cleaning is accomplished by holding the sphere under a trickle of distilled water while scrubbing it thoroughly with a brush. The white sphere should of course be cleaned in the same way at the same time (employing another brush, free from lampblack!).

Blackened spheres thus prepared and treated have held their coefficients for several months and they should hold them indefinitely. Their rates of water loss are the same as those of the best black porcelain spheres similarly exposed. In the open the hourly rate of water loss from the white sphere may be as great as 9 or 10 cc. (for the hottest part of a dry summer day at Tucson), while the corresponding rate of loss from the black or blackened sphere may be as great as 11 or 12 cc. In the open at Baltimore, in July, the white sphere loses from 30 to 60 cc. per day and the blackened one loses about 16 cc. per day more than the white one, for the clearest July days. The daily index of solar radiation for clear summer days is about 18 cc. for Tucson and about 10 cc. for Baltimore. For the greenhouse at the latter station the average daily radiation index for January is about 1.2 cc., for July about 4.0 cc.

In this and related lines of experimentation I have been ably assisted by Mr. J. D. Wilson, of this laboratory.

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REFERRED SENSATIONS CAUSED BY STIMULATION OF THE INTEGUMENT IN NORMAL GUINEA PIGS

THOUGH the curious reflexes which tactile and pressure stimuli of the integument elicit in the normal guinea pig[1] were clear and unmistakable in their expression, yet their tentative explanation proved highly unsatisfactory until a chance observation in this study gave the clew. It was then realized that many of these responses were not the immediate answers to the original stimulus but were the result of a referred, perhaps centrally radiated, sensory impression which the primary tactile or pressure stimulus had called forth. A few experimental results will illustrate this statement.

When the skin covering the right costal margin is gently rubbed with the rounded end of a slender wooden rod, the animal being free in a spacious box, then under proper conditions the animal sooner or later swiftly wipes the right front foot backwards once or twice, the toes being spread apart. Repetition of the stimulus then causes a very rapid shaking of the foot back and forth; on further stimulation the right front foot is lifted and the animal seizes the nail of the inner toe with its teeth and pulls vigorously; at times it may seize all four front toe-nails in rotation and strip them with its teeth. Stimulation on the left costal margin causes the same reaction with the left foot. Not infrequently a crossed response to the stimulus is observed: stimulation of the right costal margin calls for the reaction in the left foot or vice versa.

Pressure stimuli applied to *one lumbo-pelvic area* may cause some or all of the following responses: lateral arching of the body, the head approaching the site of stimulation; repeated rapid seizure of the hair at the point stimulated by the lips and teeth as if seeking a parasite; the mirror picture of the above, the animal seizing the hair at the symmetrical point on the opposite, non-stimulated side; the lateral aspect of the jaw on the side stimulated is vigorously scratched by the hind leg; the ear, top of the head and the lateral aspect of the jaw is wiped repeatedly by the front foot of the stimulated side, the head being rotated so that the nose is turned towards the non-stimulated side; the wiping movement is repeated by the front foot of the opposite side or the animal may sit up on its haunches wiping the top of the head, the ears and jaws simultaneously or alternately with its front feet.

Another example of dyschiria is seen when the sacro-pelvic portion of the back is stimulated by repeated tactile stimuli (bristle): the perineal region is suddenly depressed and moved forward on the floor, or occasionally both hind legs are extended forwards and by means of its front legs the animal walks forwards, scraping the perineal area along the floor.

An instructive series of motor responses apparently due to a related shifting of referred sensory impressions may be seen when the animal is examined in a small box whose floor and sides are formed by half-inch wire netting; the box is supported at each corner by columns 7 inches high, the bases also support an inclined mirror which permits easy observation of the animal's ventral aspect. Repeated stroking of the sole of the right hind foot with the tip of a wooden rod may cause all or some of the following reactions: the right hind leg is first lifted abruptly and set down with a stamp; on continuation of the stimulation the same leg is again suddenly extended forwards, and one nail of the toes, or all of them in rotation, are seized by the teeth and vigorously pulled; the stimulation being continued, there may be only a slight or no movement of the stimulated right hind foot, but the right front foot is lifted and one or more toe-nails seized and pulled; still later a crossed response is obtained and now the left hind leg is extended forwards and the toe-nails seized and pulled

[1] John Auer, SCIENCE, 1923.

by the teeth; still later, the stimulation of the right sole being continued, the animal scratches the right shoulder with the hind leg.

The impulses caused by tactile or pressure stimuli of the integument are not only referred to other skin areas, they may be referred to mucous membranes. For example, after tactile stimulation of one, the animal may suddenly rub the same or the opposite or both sides of the nose with circular movements of the radial aspect of the fist or fists. There are also sneezes and in two instances drops of milky fluid suddenly issued from a naris (nares?). Furthermore, slow, chewing motions of the jaws are very common after tactile stimulation of the skin. At times the animal seizes and chews anything available in the neighborhood: sawdust, hay, the wooden sides of the container or the netting itself. The wide opening of the jaws occasionally observed may possibly also be associated with a type of sensation referred to the buccal cavity.

In addition to these manifestations there is evidence that at least one of the special senses apparently may be involved. When an animal is tested with tactile or pressure or both types of stimuli, one may see that the animal suddenly pauses, raises its nose high in the air and samples it in various directions; or the animal abruptly sniffs interestedly in the sawdust, often spreading the sawdust by lateral sweeps of its front legs to facilitate its olfactory investigation.

It is believed that these observations may be of value in aiding the interpretation of other normal and abnormal reflex activities.

JOHN AUER

ST. LOUIS UNIVERSITY
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THE KENTUCKY ACADEMY OF SCIENCE

THE Kentucky Academy of Science held its tenth annual meeting on May 12th at the University of Kentucky, Lexington. The session was called to order at 9:30 o'clock by President Beckner.

The secretary's report showed 149 members, including 65 national members, 48 local members, 23 corresponding members and 13 honorary members. Thirty-five new members were elected.

Resolutions were passed unanimously agreeing with the resolutions adopted by the council of the American Association for the Advancement of Science with reference to their position on organic evolution. The Academy voted to hold a symposium on evolution at a meeting in Louisville, the date for which is to be determined.

The officers elected were:

President, Dr. W. R. Jillson, state geologist, Frankfort.

Vice-president, Dr. Austin R. Middleton, University of Louisville, Louisville.

Secretary, Dr. A. M. Peter, Experiment Station, Lexington.

Treasurer, Prof. W. S. Anderson, Experiment Station, Lexington.

Representative in the Council of the American Association for the Advancement of Science, Dr. A. M. Peter.

The program included an address by Dr. E. N. Transeau, head of the department of botany, Ohio State University.

The following program was rendered:

Eastern Kentucky's sea shore: LUCIEN BECKNER. The ancient shore line was described as parallel, generally, with the axis of the Cincinnati anticline and to the east of it. The general thickening of the strata eastward, with increasing distance from the shore line, was pointed out and evidence was cited of the presence of estuaries of great rivers. A very peculiar and interesting feature of the geology (stratigraphy) of Eastern Kentucky was shown by a vertical cross-section of the rock formations, extending from Lee County into Pike County, constructed by plotting well records graphically. The section shows that the deeper rocks (Devonian) continue their eastward dip into Pike County, but that this is not the case with the surface formations.

Jeptha knobs of Shelby County: WALTER H. BUCHER. The geological structure of Jeptha Knob was described as that of an upthrown fault block. The formations of which the knob itself is composed were described as horizontal and of Ordovician age. On either side of the knob evidence of faulting was observed. It was inferred that only the area included by the knob was affected by the upward movement.

The Haddix-Coalburg geosyncline: W. R. JILLSON. A study of the profile of the Haddix-Coalburg geosyncline (plotted by the writer to scale) brings out clearly for the first time the following facts: (I) This geosyncline is divisible into three units: (1) Kanawha River westward to Tug Fork, low elevations between 580 and 540 feet; (2) Tug Fork southwestward to Middle Fork of Kentucky River in Perry County, low elevations between 855 and 580 feet; (3) Middle Fork of Kentucky River to Jellico region (Tennessee line), lowest elevation 855 feet and highest elevation 1,600 feet. (II) Regional coincidence of pronounced structural highs in Floyd and Clay Counties with important developed gas fields, and lack of coincidence with large and important developed oil pools in all of its course until the Cabin Creek region of southern Kanawha County, West Virginia, is entered. (III) Coincidence of synclinal structure with all lines of major drainage from the South Fork of the Kentucky River northeastward to the Kanawha River.

Land of ten thousand sinks: W. R. JILLSON. The pitted or sink-hole characteristic of the St. Louis, Ste. Genevieve and Chester divisions of the Mississippian System in Kentucky has long been recognized. The widely ramifying sub-surface drainage developed in these limestone rocks, which are frequently of high purity, is well exemplified in the karst and cave region of Edmonson

County, Kentucky, and in the natural sewage channels of the City of Bowling Green, Warren County, Kentucky. The peculiar topographic figure of the "sink" country is well shown on either side of the Louisville and Nashville Railroad, and the Dixie Highway from Munfordville in Hart County to Bowling Green. The recently completed Mammoth Cave topographic sheet exhibits 2,833 sink-holes, and is regarded as a model for students. The number of sinks on other completed quadrangles follows: Brownsville 1,150, Bowling Green 2,563, Princeton 1,429, and Monticello 1,096, giving a total of 9,071. The Brownsville topographic sheet shows the largest mapped sink-hole, just south of the Dripping Springs escarpment, between Girkin and Tuckertown postoffices. This gigantic sink has an area of 4.865 square miles or 3,114 acres. It is estimated on a basis of mapped areas that the Mississippian plateau in Kentucky contains between sixty and seventy thousand sink-holes of varying size and description.

A gigantic slate slide: W. R. JILLSON. The largest and most destructive "slate slide" in the history of mining operations in Kentucky occurred at Burdine, Letcher County, on the waters of Elkhorn Creek, adjoining the northwest flank of Pine Mountain, on February 3, 1923. About 360 cubic yards of "slate" taken from the parting of the Elkhorn coal (Pottsville) at Mine No. 201 of the Consolidation Coal Company and gobbed in Slate Hollow became supersaturated with rainwater and wash during an abnormal precipitation of 3.27 inches for the 48 hours immediately preceding the slide. The direct causes of this slide were: (1) Abnormal precipitation combined with inadequate sub-slate drainage; (2) unstable angles of rest (35°) on the breast of the fill; (3) excavation and ditching operations following the first minor slips; (4) seismological disturbances of record, and (5) unusual regional geotectonic relationships. The total length of the slide was 929 feet. The semiliquid "slate" moved out fan-shaped entirely across the bottom of Elkhorn Creek to a maximum depth of 75 feet. The movement was entirely within the "gobbed" slate and did not affect the underlying country rock or soil. Casualties were narrowly avoided.

The largest fort of the mound builders in the knobs of Kentucky: WILBUR GREELEY BURROUGHS. The fort is in Madison County, Kentucky, 3½ miles southeast of Berea, on the flat top of a mountain, 620 feet vertically above the surrounding valleys. It covers about 250 acres. Rough stone barricades guard each of 13 possible approaches and cliffs 100 to 180 feet high form the other sides. Even certain accessible joint planes four feet wide are barricaded with regularly laid rough stone walls. Piles of stone "ammunition" occur at intervals. The author made the first detailed survey and explored this fort in 1922–23 for the State Geological Survey. With voluntary assistants he has excavated in the caves and rockhouses of the fort in search of remains of the prehistoric people.

The social significance of psychological tests for college students: J. B. MINER. Three statistical pictures of the results of the Army Alpha test conducted at the University of Kentucky were presented. The first shows how closely the scores of the freshmen parallel the distribution curve of the officers in the American army. This indicates the high type of individual which the university has to train and the importance of clear recognition by the student body that it is fitting itself for positions of leadership and responsibility. The second compares the seniors with the freshmen in the College of Engineering. It furnishes a start towards the problem of defining the minimum essential of intellectual capacity necessary for completing the engineering course. The third shows tests of the twelve Kentucky candidates for the Rhodes Scholarship in the recent award. The results corroborate the opinions of the committee which made the selection after an elaborate comparison of the personal histories and the scholarship records of the candidates, supplemented by a half-hour interview with each man. It shows strikingly that high records on the psychological tests are correlated with the sort of personal characteristics sought in making this appointment.

Notes on the constitution of benzene: C. C. KIPLINGER. The author attempts to prove that Kekulé's vibration hypothesis, with a slight modification, is still as fruitful in affording explanations of the chemical behavior of benzene and related structures as the more complex hypotheses of later development. It is a fallacy to expect two ortho di-substitution products of benzene, since these could be but two special phases of the vibration cycle of a Kekulé molecule, which cycle probably occurs very rapidly. The Thiele molecule becomes a special phase of this cycle. The structures of naphthalene and anthracene are discussed briefly along the same lines. The paper is speculative and presents no new experimental evidence.

Ulcerative cloacitis in chickens: M. SCHERAGO. This is either a rare disease in Kentucky or it is not readily recognized by the poultryman. If the latter, the number of cases must be very few and the disease itself of little importance. The rather sporadic occurrence of ulcerative cloacitis in a flock and failure to transmit the disease to healthy fowls seem to indicate that it is not contagious and is not transmitted by coitus. Birds affected may be treated with a single cleansing of the anal region and cloaca and one or two applications of a 1–1000 solution of mercuric chlorid; they recover without further treatment. An attack of this disease does not seem to affect the future laying capacity of the hen.

Effect of developing fetus on production of milk of dairy cows: J. J. HOOPER. Records of 24 cows studied indicate that the growing fetus, five or six months after conception, exerts a decided influence in checking milk secretion of the mother cow. When left unbred for most of the lactation, cows maintained a higher milk yield during the last months than when bred early. The author infers that the six-months' old fetus secretes something that dries off the cow preparatory to rest and calving.

Market milk—free from B. Coli: E. J. GOTT and L. A. BROWN. The Public Service Laboratories of the Kentucky Agricultural Experiment Station have made a B. coli count as a routine procedure in the examination of milks for the past eleven years. In order to determine if market milk was absolutely free from members of the